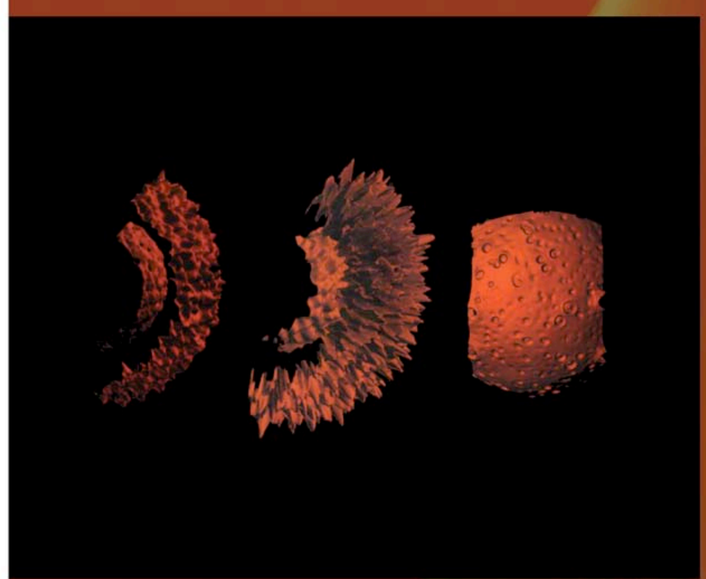
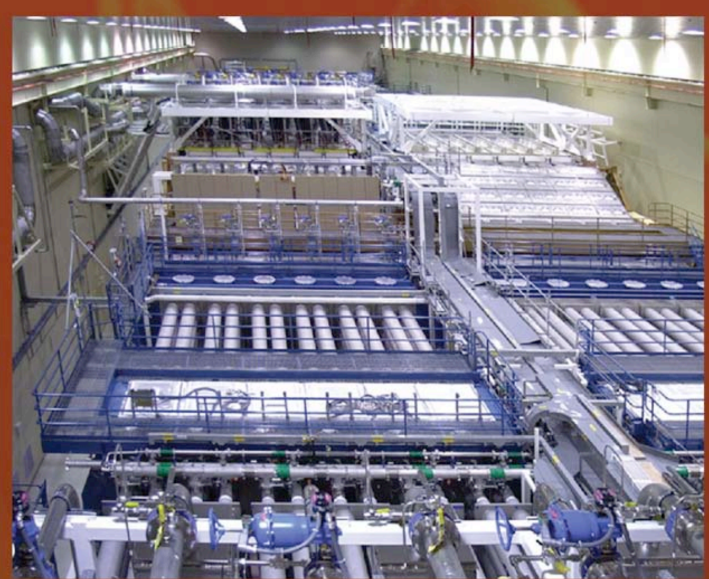
Predictive Capability

Visualizing and Understanding Complex Physics and Engineering

Predictive capability is the ability to simulate with confidence the performance, safety, and surety of the nuclear stockpile. ASC will provide the models, codes, and computing infrastructure to visualize and understand the complex physics and engineering, and quantify margins and uncertainties. The outermost layer of the graphic to the left shows NNSA experimental facilities that provide the elements of discovery for the development of theoretical models—models that describe the physics of nuclear weapons. Within the next layer, these theoretical models represent the basis of sub-grid scale simulations. The third layer shows continuum-scale simulations of weapon components and sub-components that are validated by experimental data from the same or similar experimental facilities. Finally, the innermost layer depicts full-scale weapons to which system-level simulations are applied for assessing safety and reliability with quantified design margins and uncertainties.

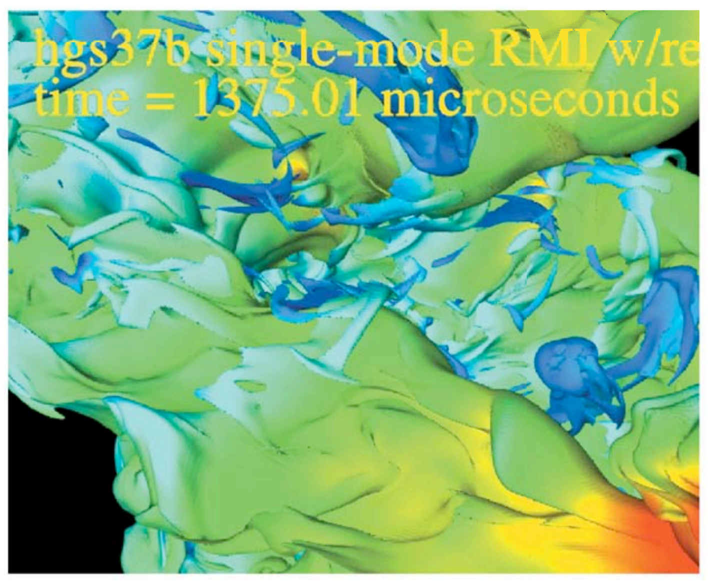
Supercomputing
Conference 2005





ASC is developing sophisticated three-dimensional computer simulations based on predictive physical models. In the image on the left, isodensity surfaces of a NIF ignition capsule bounding the shell are shown at 200 ps (picoseconds, or 10-12 seconds, left) and 100 ps (center) prior to ignition. Density contours of rebounding shock near ignition time are shown (right). The image on the right is the National Ignition Facility (NIF) laser bay at Lawrence Livermore National Laboratory in California.

Growth of multiple helium bubbles is simulated within a metallic lattice in which the helium bubbles are placed in proximity to a free surface. The bubbles themselves are modeled using force fields with time-varying ranges. The growing bubbles produce crystalline defects including vacancies, dislocation threads, and stacking fault tetrahedra. The dislocation threads are observed not only to interconnect the bubbles, but also to create paths to the free surface.



Simulation of a shock tube experiment showing the evolution of the instability produced by the interaction of a shock with a fluid interface. The simulation of compressible, turbulent mixing like this is used for verification and validation of our physics models that are relevant to the shocked conditions of materials for the ASC Program.

Visualize the Difference

National Nuclear Security Administration